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Message from the Chair

Aaron C. Clark
North Carolina State University

2012 looks to be a great year for the division! I have heard many members indicate this at meetings and I believe it is to be true. With conferences in Texas and our first Mid-Year Meeting to be held in internationally in Ireland, this is truly a great year for the engineering design graphics division. But, with all of these many ways that professionals in our field come together and fellowship and promote their research and projects, we still need to support our efforts through publishing new findings through our journal. I would like to challenge all members to consider submitting for publication in our journal sometime this year. I know that many of you are busy and involved in other groups that have refereed publications as well, but if it's about our discipline of graphics and you feel would be good knowledge for the profession of engineering graphics, please send your manuscripts to our journal of Engineering Design Graphics (EDGJ). I would like to thank Bob Chin for his leadership as Director of Publications and Journal Editor. Also, a special thank you goes out to AJ Hamlin as Associate Editor and Carolyn Dunn as Assistant Editor. We all appreciate the efforts of Kathryn Holliday-Darr as Circulation Manager/Journal Treasure, Ted Branoff as Photographer, and Cody Skidmore as the journal's Web Production Manager. It takes a great team like this to have the quality journal that members and researchers throughout the world can rely on for new knowledge for our respective fields and disciplines. Again, thanks for the work you have done as an editorial team.

Professionally yours,
Aaron C. Clark, DTE
Chair

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Message from the Editor

Robert A. Chin
East Carolina University

A couple of *EDGJ* initiatives are underway. One will be looking at the composition of the *EDGJ's* review board. The purpose is to ensure that the composition of the review board is consistent with the mission of the EDGD and the *EDGJ*. If it is not, there may be a need to recruit reviewers to round out the composition of the review board to ensure we have the necessary expertise to service the Division and the *Journal*.

Kathy Holliday-Darr, the *Journal's* Circulation Manager and Treasurer, is in the process of scanning editions of the *Engineering Design Graphics Journal*, the *Journal of Engineering Drawing*, and the *Journal of Engineering Drawing*. The latter two are predecessors of our current journal. Once they're scanned, we'll begin uploading them to the online *EDGJ* site so they can be view. We'd welcome some help uploading the files.

Nicholas Bertozzi, the Division's Director of Communications, is in the process of reformatting the Mid-Year Conference Proceedings—see http://edgd.asee.org/conferences/proceedings.htm We're in the process of getting the proceedings indexed by the Education Resources Information Center**.**

What's being read? From Sep 26, 2010 through Apr 1, 2012, the top five most frequently viewed feature articles published in the online version of the *EDGJ* are the following:

- Carol M. Lamb and David G. Kurtanich's Drafting the Basics with 2,477 page views—see http://www.edgj.org/index.php/EDGJ/article/viewFile/8/7
- Sheryl A. Sorby's Developing 3-D Spatial Visualization Skills with 2,473 page views—see http://www.edgj.org/index.php/EDGJ/article/viewFile/126/122
- Theodore J. Branoff's Spatial Visualization Measurement: A Modification of the Purdue Spatial Visualization Test - Visualization of Rotations with 1,382 page views—see http://www.edgj.org/index.php/EDGJ/article/viewFile/145/141
- H. K. Ault's Cam Design Projects in an Advanced CAD Course for Mechanical Engineers with 904 page views—see http://www.edgj.org/index.php/EDGJ/article/view/17/16
- Daniel M. Chen's Application of 3D CAD for Basic Geometric Elements in Descriptive Geometry with page 761 views—see http://www.edgj.org/index.php/EDGJ/article/viewFile/138/134

We continue to welcome suggestions for improving the Journal.

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Election Results

According to the Division by-laws (see http://edgd.asee.org/aboutus/edgdbylaws.htm), the chair of the Elections Committee shall transmit the results of the election to the Chair of the Division. The Chair shall inform each candidate (including those not elected) of the results of the election for his office and shall transmit the names of the newly-elected officers to the Editor of the Journal for publication in the Spring issue of the Journal. The chair of the Elections Committee shall report the results of the election to the Division at the annual business meeting. The results for the most recent election are as follows:

For Vice-Chair: Dennis Lieu

Dennis Lieu received his BS, MS and D.Eng. in Mechanical Engineering from UC Berkeley in 1977, 1978 and 1982, respectively. After working for six years as a design engineer in industry, he returned to UC Berkeley as a member of its faculty. Prof. Lieu has taught engineering graphics at Berkeley for over 20 years, and has been a member of EDGD for 18 years. He was the host of the EDGD Midyear Conference in Berkeley in 2002 and again in 2009. He is the author or co-author of numerous articles on engineering graphics education, and is co-author (with Sheryl Sorby) of *Visualization, Modeling, and Graphics for Engineering Design*, published by Cengage. His research interests are in the design of electro-mechanical actuators and the design of sports equipment. He is a member of Tau Beta Pi, Pi Tau Sigma, and Phi Beta Kappa, and is a recipient of the University of California Distinguished Teaching Award. In 2008, he was awarded the Orthogonal Medal by North Carolina State University for his contributions to engineering graphics education. If elected as an officer in EDGD, his goal would be to expand the size and scope of the Division to include non-traditional areas.

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For Secretary/Treasurer: Norma L. Veurink

Norma L. Veurink is a Senior Lecturer in the Engineering Fundamentals Department at Michigan Technological University where she teaches introductory engineering courses which include engineering graphics. She teaches a spatial visualization course designed for engineering students with poor spatial visualization skills. Ms. Veurink manages several summer programs that introduce middle and high school students to engineering. She is active in the American Society for Engineering Education and the American Society of Civil Engineers. Her research interests include spatial visualization, engineering education and first-year programs.

For Director of Publications: Robert A. Chin

Robert A. "Bob" Chin is a Professor in the Department of Technology Systems, College of Technology and Computer Science at East Carolina University, where he's taught since 1986. In addition, he is a full member of the East Carolina University and Indiana State University graduate faculties. Chin received his PhD from the University of Maryland, College Park; MAE from Ball State University; BA from the University of Northern Colorado, and AAS from the Community College of the Air Force. Before joining the ECU faculty, he was on the College of Education faculty at the University of Maryland, College Park. Chin is an active member of ASEE. He has presented numerous papers at annual conferences, FIE, mid-year conferences/meetings, and at ASEE's Southeastern Section meetings. He has had numerous journal articles published including several in the Engineering Design Graphics Journal. He has served as the Engineering Design Graphics Division's Director of Programs, as annual and mid-year conference/meeting program chair and he has served as a review board member for the EDGJ. Chin has been a program chair for the Southeastern Section Meeting and has served as the EDGD's Vice-Chair and Chair and as the Instructional Unit's Secretary, Vice-Chair, and Chair. He is the current EDGD Director of Publications and is the current EDGJ Editor.

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Attitudes and Motivation of Students in an Introductory Technical Graphics Course: A Meta-analysis Study

Jeremy V. Ernst
Virginia Tech

Aaron C. Clark
North Carolina State University

Abstract

Students in introductory engineering graphics courses at North Carolina State University (NCSU) were asked to complete surveys to help educators and administrators understand their attitudes toward learning and their motivation to learn. Analyses of the completed surveys provided the Graphic Communications Program at NCSU with an understanding of ways in which their classes fulfill or fail to fulfill their mission to teach graphic concepts and methodology and to generate an appreciation for the function of graphics in professional and personal day-to-day experiences. Two surveys were used in this study. The first, a survey of 43 questions based on the Colorado Learning Attitudes about Science Survey (CLASS), was used to evaluate attitudes and opinions toward technical graphics; the second, a 31-item motivational survey based on the Motivated Strategies for Learning Questionnaire (MSLQ), was used to evaluate student motivation. This paper presents thorough individual and comparative analyses of the data obtained from both surveys and discusses several important implications.

Introduction

Student attitudes and motivation are major topics of investigation in all educational disciplines. It is important to understand not only the role of attitudes in student interest and understanding but also how practitioners can motivate students to learn. This study investigates the role of students' motivation to learn and their attitudes toward learning in engineering graphics courses, while drawing from multi-disciplinary information associated with attitude and motivation.

Attitudes

Students' attitudes about curricular and instructional practices in graphics education and other disciplines may be centered on their interests and beliefs about the content. Adams et al. (2006) have found that considering students' interests and beliefs can help create a logical form of instruction that appeals to different student groups. Further, adult learning research suggests that when instruction is provided in an appealing manner, learning gains can increase (Hein & Bundy, 1999), and when students are more engaged in the classroom, their attitudes may change and they may become increasingly motivated to learn (McIntosh, Berman, & Youniss, 2007). Thus, professional educators focus on increasing student understanding and knowledge, while motivating students to appreciate what they are learning. If instruction motivates

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students, then students are likely to value their endeavors and alter their attitudes to seek future educational experiences similar to the ones that initially motivated them (Durik & Harackiewicz, 2007).

Motivation

Many motivational processes are responsive to individual properties associated with tasks, the classroom, and the context of student engagement (Wolters & Pintrich, 1999). Literature on student motivation identifies many beliefs and constructs, but control, competence, and self-regulated strategic learning remain chief among them (Shell & Husman, 2008). Knowles, Holton, and Swanson (1998) believe that both internal and external pressures contribute to adult learner motivation. The attitude of self-determination is the nucleus of support for students (Johari & Bradshaw, 2008). This attitude is primarily a result of feeling competent, which in adults can be highly motivational when paired with internal pressures. Self-determination plays a major role in extrinsic motivation as well and refers to “engaging in an activity to obtain an outcome separable from the activity itself” (Vansteenkiste et al., 2008).

A recent study, conducted by Bye, Pushkar, & Conway (2007), identified intrinsic motivation as a predictor of a positive classroom effect. The value of motivation can be conceptualized through various approaches (e.g., learning vs. performance goals, intrinsic vs. extrinsic orientation, and interests), and it effectively concerns students' motives for the completion of a task (Pintrich, 1999). In addition, self-efficacy plays a major role in student motivation at both intrinsic and extrinsic levels. There are many circumstances where students assume and perform activities they deem themselves capable of completing and avoid those they believe to be beyond their ability (Yang, 1999). Therefore, self-efficacy plays a major role in motivation in the classroom.

Instruments

The first instrument used in this study is the Colorado Learning Attitudes about Science Survey (CLASS). This research study builds on prior efforts but is structured to provide insight into engineering student interests and beliefs by using a modified version of CLASS, known as the North Carolina Learning Attitudes about Graphics Education Survey (NCLAGES). Educational psychologists have conducted extensive research on student interest and motivation across disciplines (Perkins et al., 2006a). Over the past decade, a targeted group has been students enrolled in introductory science courses at the postsecondary level (Perkins et al., 2006b). An objective of postsecondary education is to convey information and skills of practical value to students. It is relatively easy to assess the imparting of knowledge, but what students believe, appreciate, value, and will be receptive to is not as easily assessable (Lieberman & Remedios, 2007).

The second instrument is the Motivated Strategies for Learning Questionnaire (MSLQ) designed to evaluate “college students’ motivational orientation and use of different

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learning strategies for a college course" (Pintrich, Smith, Garcia, & McKeachie, 1991). The broad cognitive analysis of motivation and learning strategy, paired with the social cognitive view of motivation and self-regulated learning, serves as the foundation of MSLQ. Numerous MSLQ studies present evidence of internal consistency, reliability, and predictive validity of the instrument (Pintrich, Smith, Garcia, & McKeachie, 1993; Artino, 2005; Duncan & McKeachie, 2005). The MSLQ represents a theory-based method to accurately and holistically gauge student motivation and self-regulated learning.

Methodology

Attitudes

This investigation utilized a modified version of the CLASS survey. The statements were rewritten to produce a similar survey for examining the attitudes of students toward engineering graphics and learning engineering graphics. The original survey was composed of 42 statements, which respondents rate on a five-point Likert scale. The graphics version, known as NCLAGES, consists of 43 statements as well as demographic questions.

In the Fall semester of 2007, seven randomly selected sections of GC 120: Foundations of Graphics at NCSU were used in the study. GC 120 is an introductory course designed to teach the fundamentals of engineering/technical graphics. The course is listed on the university's general education requirements as an elective under the Visual and Performing Arts category; therefore, it attracts both engineering and non-engineering majors. The majority of students are engineering majors or in technical fields. Each section of the course consisted of 24 students and was taught over 15 weeks. GC 120 includes instruction in SolidWorks 3D modeling software and basic instruction in the concepts of engineering drawing, including sketching, geometric construction, isometric drawings, multiviews, auxiliaries, sections, dimensioning, and working drawings. Students were asked to complete the survey during the thirteenth week of class, thereby allowing them to benefit from the majority of the course prior to completing the survey.

Motivation

The second survey used was the MSLQ. The researchers utilized the results of the MSLQ Attitude Survey to examine the six proposed null hypotheses listed below concerning motivation and satisfaction of student learning.

1. H_0: Student intrinsic goal orientation elements are independent components of motivation and learning.
2. H_0: Student extrinsic goal orientation elements are independent components of motivation and learning.
3. H_0: Student task value elements are independent components of motivation and learning.

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4. H_0: Student controls of learning beliefs are independent components of motivation and learning.
5. H_0: Student self-efficacy and learning performance elements are independent components of motivation and learning.
6. H_0: Student test anxiety elements are independent components of motivation and learning.

To better gauge indicators of student attitude and motivation, the MSLQ data analysis was shortened. As prescribed by Matthews (2004) to solely measure motivation concerning goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy learning performance, and test anxiety, the MSLQ analysis was limited to 31 questions. Additionally, Matthews identified an MSLQ item equivalent subset to provide a targeted analysis of the six focal areas associated with student learning and motivation.

In the tenth week of the 2008 Spring semester, the course instructors administered the MSLQ instrument to student participants in the introductory engineering graphics course. One hundred sixty-one students in seven separate sections of GC 120: Foundations of Graphics completed and returned the survey.

Results

Attitudes: Results from NCLAGES

One hundred sixty-one NCLAGES completed surveys provided usable data for analysis. Students were asked to rate each of the 43 statements to express their closest feeling about a given statement. The Likert scale categories were: (1.) Strongly Disagree, (2.) Disagree, (3.) Neutral, (4.) Agree, (5.) Strongly Agree. If they did not understand a statement, they could leave it blank.

In the original CLASS survey, statements were comprised of nine categories of content defined and described by Adams et al. (2006). Students were not made aware of the groupings of the statements. Many of the statements were used in more than one category and grouping. These statements were repeated to help the reader draw conclusions from the grouping of a like content from the statements as they relate to corresponding categories.

In the NCLAGES study, the researchers followed the same procedure with students not being made aware of the statements groupings. The survey used in this study incorporated names and definitions similar to the original instrument but took the liberty of making changes to suit the content of the course surveyed and the type of students enrolled in it. Note that the categories and definitions are the interpretations and working definitions of the authors of this study only; inferences made from other studies that used the original CLASS survey were only referenced for the classification, labeling, and definition development for the data collected from this survey instrument.

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The NCLAGES category labels, definitions, and sample statements are:

Group 1: *Real World Relations* which describes how students relate information to scenarios includes statements such as "Learning graphics changes my ideas about how the world works," "The subject of graphics has little relation to what I experience in the real world," and "To understand graphics, I sometimes think about my personal experiences and relate them to the topic being analyzed."

Group 2: *Personal Interest* defines students' interests in areas of visualization and graphics and includes statements such as "I think about the graphics I experience in everyday life," "I am not satisfied until I understand why something works the way it does," and "I study graphics to learn knowledge that will be useful in my life outside of school."

Group 3: *Sense Making* indicates whether students understand usefulness of materials being studied and includes statements such as "I am not satisfied until I understand why something works the way it does," "In doing a graphic-based problem, if my method gives a result very different from what I'd expect, I trust the calculation rather than going back through it" and "In graphics, it is important for me to make sense of engineering and design concepts before I can use them correctly."

Group 4: *Conceptual Associations* demonstrates the way students relate to materials and make comparisons and includes statements such as "A significant problem in learning technical graphics is being able to memorize all the information I need to know," "After I study a topic in graphics and feel that I understand it, I have difficulty solving problems on the same topic," and "Knowledge in graphics consists of many disconnected topics."

Group 5: *Applied Understanding* describes how students could apply content in and beyond the classroom environment and includes statements such as "A significant problem in learning technical graphics is being able to memorize all the information I need to know," "After I study a topic in graphics and feel that I understand it, I have difficulty solving problems on the same topic," and "Knowledge in graphics consists of many disconnected topics."

Group 6: *Problem Solving* describes how students use the content presented in class to solve general and basic problems related to graphics and includes statements such as "I do not expect graphic and design concepts to help my understanding of the ideas; they are just for doing working drawings," "If I get stuck on a graphic problem my first try, I usually try to figure out a different way that works," and "Nearly everyone is capable of understanding graphics if they work at it."

Group 7: *Confidence in Problem Solving* shows if students are comfortable using the information from the course and includes statements such as "Nearly everyone is

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capable of understanding graphics if they work at it," "I can usually figure out a way to solve graphic problems," and "If I get stuck on a graphic problem, there is no chance I'll figure it out on my own."

Group 8: *Advanced Problem Solving* demonstrates the use of higher-order thinking skills in relation to content covered in the course and includes statements such as "After I study a topic in graphics and feel that I understand it, I have difficulty solving problems on the same topic," "If I don't remember a particular strategy needed to solve a problem on an exam, there's nothing much I can do ethically to come up with it," and "If you want to apply the method used for solving one graphic problem to another problem, the problems must involve very similar situations."

Group 9: *General Attitudes* provides information concerning students' overall feelings toward a course of this type and includes statements such as "It is useful for me to do lots and lots of problems when learning graphics," "As graphic professionals learn more, most technology-based ideas we use are likely to be proven wrong or become outdated," and "I do not spend more than five minutes stuck on a graphic problem before giving up or seeking help from someone else."

Clark, Ernst and Scales (2008) provide a detailed list of statements included in each category. Question 31 which states "*We can use this statement to discard the survey of people who are not reading the statements. Please select agree-option 4 (not strongly agree) for this statement,"* was used as a control statement. This statement was part of the original survey and was used to control for participants not taking the survey seriously; therefore, if the response to this statement was not a four (4) on a participant's survey, it was discarded from the analyzed data for this study. In this study 16 instruments were eliminated by the responses to the control statement. The overall mean for this question was 3.89 with a standard deviation (SD) of .38 and a mode of 4; therefore, the researchers concluded that the majority of students took the time to read and respond to the statements.

The population of the NCLAGES survey mainly consisted of sophomores majoring in engineering, with 91 percent of their ages ranging between 18 and 21. The majority of the participants considered themselves to be visual (58 percent) or multi-modal (36 percent) learners. Of the favorite hobbies listed by participants, the majority were visual in nature consisting of two-dimensional (i.e. games) and three-dimensional (i.e. baseball, soccer) environments. Overall, most of the student participants indicated they felt the content covered in the course would be useful in their future job or career.

An evaluation and comparison of the Likert mean and mode values for each statement in a category allowed the researchers to draw some conclusions about student attitudes (Clark, Ernst and Scales, 2008). The real-world relations' values indicated that students understood how the covered content could be used beyond the course, and they appreciated the hands-on method of instruction associated with it. In terms of personal interest, the students felt the course's visual content and graphics could be used in

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everyday activities. The highest mode values for any grouping of statements in the study were found in the category of making sense of the information students learned in the course. Results of the study indicate that students view the information and processes taught in the course as a form of problem solving.

Many students see graphics education and visual skill development as a necessary basic in education but difficult to learn. The authors concluded that students entering college understand that a difference exists between visual ability and visual skill and the need to increase their knowledge of visualization and communications. Students seemed comfortable using this knowledge to communicate technically and to visually problem-solve as well as understand the function of geometric constructions taught in the class. However, they also indicated they felt the need to have direct communication with the instructor and higher quality of instruction. Overall, students' ratings in the category of attitudes, as indicated by the NCLAGES survey, concerning a fundamentals course in graphic communications was dominantly "strongly agree".

Motivation: Results from MSLQ

The identified MSLQ item equivalents to investigate intrinsic goal orientation were Items 1, 16, 22, and 24 (Table 1). As a group, the intrinsic goal orientation items

Table 1**.** *MSLQ Intrinsic Goal Orientation*

Item	Mean	Sample Var.	DF	Chi-Square	P-value
1. In a class like this, I prefer course material that really challenges me so I can learn new things.	4.56	1.523059	160	243.68944	<0.0001
16. In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.	5.26	2.1065218	160	337.0435	<0.0001
22. The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible.	4.73	1.5344721	160	245.51553	<0.0001
24. When I have the opportunity, I choose course assignments I can learn from even if they aren't hard enough.	4.18	1.6587657	159	263.74374	<0.0001

averaged 4.68 on the 7-point scale; Item 16 had the highest average while Item 24 had the lowest. Evaluation of the chi-square statistic and the proportional value associated

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with each item identified all items within their student learning and motivation area as significantly different from one another, given the predetermined alpha level of significance (0.05).

Table 2 lists the identified item equivalents to investigate extrinsic goal orientation. As a group, the extrinsic goal orientation items averaged 5.35; Item 13 had the highest average while Item 30 had the lowest. Reporting and evaluation of the chi-square statistic and the proportional value associated with each item identified three of the four items were significantly different from one another. Item 13 did not differ significantly within the subgroup. However, Items 7, 11, and 30 were found to significantly differ.

Table 2. *MSLQ Extrinsic Goal Orientation*

Item	Mean	Sample Var.	DF	Chi-Square	P-value
7. Getting a good grade in class is the most satisfying thing for me right now.	5.09	2.7048912	160	432.78262	<0.0001
11. The most important thing for me now is improving my overall grade point average, so my main concern in this class is getting a good grade.	5.27	2.6998448	160	431.97516	<0.0001
13. If I can, I want to get better grades in this class than most of the other students.	6.19	1.1025621	160	176.40994	0.3551
30. I want to do well in this class because it is important to show my ability to my family, friends, employer, or others.	4.84	2.6319876	160	421.118	<0.0001

Table 3 lists the identified item equivalents to investigate task value. Within the item equivalents for task value, the six items provide participant averages relatively close to one another. As a group, the task value items averaged 5.16. Evaluation of the chi-square statistic and the proportional value associated with each item identified all items within their student learning and motivation area as significantly different from each other.

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Table 3. *MSLQ Task Value*

Item	Mean	Sample Var.	DF	Chi-Square	P-value
4. I think I will be able to use what I learn in this course in other courses.	5.02	2.2684007	160	362.9441	<0.0001
10. It is important for me to learn the course material in this class.	5.50	1.3015528	160	208.24844	0.0123
17. I am very interested in the content area of this course.	5.00	1.85	160	296	<0.0001
23. I think the course material in this class is useful for me to learn.	5.20	1.5639751	160	250.23602	<0.0001
26. I like the subject matter of this course.	5.26	1.9815217	160	317.0435	<0.0001
27. Understanding the subject matter of this course is very important to me.	5.00	1.8437111	160	294.99377	<0.0001

The identified item equivalents that examined control of learning beliefs were MSLQ Items 2, 9, 18, and 25 (Table 4). As a group, the control of learning beliefs items

Table 4. *MSLQ Control of Learning Benefits*

Item	Mean	Sample Var.	DF	Chi-Square	P-value
2. If I study in appropriate ways, then I will be able to learn the material in this course.	5.84	1.3444875	160	215.11801	0.0048
9. It is my own fault if I don't learn the material in this course.	5.62	1.6602484	160	265.63974	<0.0001
18. If I try hard enough, then I will understand the course material.	6.04	1.0293478	160	164.69565	0.7663
25. If I don't understand the course material, it is because I didn't try hard enough.	4.96	2.104348	160	336.69565	<0.0001

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averaged 5.62; Item 18 had the highest average while Item 25 had the lowest. The reporting and evaluation of the chi-square statistic and the proportional value associated with each item identified three of the four MSLQ items within their student learning and motivation area as significantly different from one another, given the predetermined alpha level of significance (0.05). Item 18 was found not to differ within the response subgroup. However, Items 2, 9, and 25 were found to significantly differ.

Table 5 lists the identified item equivalents to investigate self-efficacy learning performance. Within the item equivalents of self-efficacy learning performance, the eight items present participant averages relatively close to one another. As a group, the self-efficacy learning performance items averaged a 5.47. Additionally, the evaluation of the

Table 5. *MSLQ Self-Efficacy Learning Performance*

Item	Mean	Sample Var.	DF	Chi-Square	P-value
5. I believe I will receive an excellent grade in this class.	5.24	1.618944	160	259.03107	<0.0001
6. I'm certain I can understand the most difficult material presented in the readings for this course.	5.18	1.9986025	160	319.7764	<0.0001
12. I'm confident I can learn the basic concepts taught in this course.	5.47	2.4132764	160	386.12424	<0.0001
15. I'm confident I can understand the most complex material presented by the instructor in this course.	5.48	1.6388199	160	262.21118	<0.0001
20. I'm confident I can do an excellent job on the assignments and tests in this course.	5.60	1.0672361	160	170.75777	0.5317
21. I expect to do well in this course.	5.69	1.2029504	160	192.47205	0.0815
29. I am certain I can master the skills being taught in this course.	5.58	1.5289308	159	243.1	<0.0001
31. Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class.	5.52	1.563587	160	250.17392	<0.0001

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chi-square statistic and the proportional value associated with each item identified six of the eight MSLQ items within their student learning and motivation area as significantly differing from one another based on the predetermined alpha level of significance (0.05). Items 20 and 21 were found not to significantly differ within the response subgroup. However, Items 5, 6, 12, 15, 29 and 31 were found to significantly differ.

Table 6 lists the identified item equivalents to investigate test anxiety. As a group, the task value items averaged 3.74; Item 14 had the highest average while Item 3 had the lowest. Evaluation of the chi-square statistic and the proportional value associated with each item indicated that all five of the MSLQ items significantly differed from each other and exceeded the predetermined value for significance.

Table 6. *MSLQ Test Anxiety*

Item	Mean	Sample Var.	DF	Chi-Square	P-value
3. When I take a test I think about how poorly I am doing compared with other students.	3.09	3.5225155	160	563.6025	<0.0001
8. When I take a test I think about items on other parts of the test I can't answer.	4.24	3.1689441	160	507.03107	<0.0001
14. When I take tests I think of the consequences of failing.	4.30	4.2880435	160	686.087	<0.0001
19. I have an uneasy, upset feeling when I take an exam.	3.77	3.2406056	160	518.4969	<0.0001
28. I feel my heart beating fast when I take an exam.	3.31	3.5154502	160	562.47205	<0.0001

The sampling variance reported in the data summations was due to statistical fluctuation in the responses. The results of the MSLQ survey found no significant differences between categories but some interesting findings nevertheless. Item 13 ("If I can, I want to get better grades in this class than most of the other students") in the Extrinsic Goal Orientation subgroup, Item 18 ("If I try hard enough, then I will understand the course materials") in the Control of Learning Beliefs subgroup, Item 20 ("I'm confident I can do an excellent job on the assignments and test in the this course"), and Item 21 ("I expect to do well in this class") of the Self-Efficacy Learning Performance subgroup were identified by the study as continuing motivational and learning factors for learning engineering graphics in the introductory engineering graphics course at NCSU. Considering that these statements "stand out" among the

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others and that each in some way is associated with the level of understanding and the grade they wish to receive in class, grades are still a good motivational factor to consider with these participants. The ability to do well and see relevance in what is being taught is also paramount to a student's motivation in a course, such as fundamentals of engineering graphics. From the data collected for this study, it can be observed that grades, relevance of content, and understanding subject matter are the main factors that affect students' motivation.

Comparing NCLAGES and MSLQ Results

Summary statistics (Table 7) of the NCLAGES and MSLQ were calculated to provide a synopsis of the instrument results. The variance (0.28) and standard deviation (0.53) of the MSLQ results are minimal in comparison to the variance (1.10) and standard deviation (1.05) of the NCLAGES results indicating a smaller spread of participant ratings on the MSLQ. The standard error (0.05) of the MSLQ results is smaller than the standard error (0.08) of the NCLAGES results uncovering a larger fluctuation in ratings from participant to participant in the NCLAGES results. The range is calculated based on the minimum and maximum scores on the MSLQ and NCLAGES results. The sizable range (5) on the MSLQ in relation to the performance assessment range (3.25) reiterates the degree of difference in variability of the two instruments.

Table 7. *Summary Statistics*

Instrument	N	Variance	S.D.	S.E.	Range
MSLQ	101	0.28	0.53	0.05	3.25
NCLAGES	161	1.10	1.05	0.08	5

A hypothesis test was conducted given the discrepancies in means and standard deviations of the MSLQ and NCLAGES participants indicated in Table 1. The Z-score was calculated using the following null hypothesis: There are no significant differences in means of the MSLQ and NCLAGES participants' perception survey results. Based on an analysis of the Z-statistic (33.32) and the proportional value (<0.0001), the null hypothesis is rejected, providing evidence that there is a significant difference between the means of the students' overall survey results (refer to Table 8).

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Table 8. *Hypothesis Test Results*

MSLQ (n)	NCLAGES (n)	Sample Mean	S.E.	Z-Stat	P-value
101	161	3.27	0.10	33.32	<0.0001

Correlation coefficients were calculated to determine the relation of the NCLAGES categorical groups (as prescribed by the CLASS survey) and the MSLQ items identified as continuing motivational and learning factors through the *Motivation and Strategies for Learning in a Fundamentals of Graphics Education Course* study. Thirty-six correlation coefficients were calculated. Each coefficient assisted in determining the strength of the association between the variables (NCLAGES groups and the motivational and learning factors identified through the MSLQ previous study). These coefficients were calculated from MSLQ Item 13 ("If I can, I want to get better grades in this class than most of the other students") in the Extrinsic Goal Orientation subgroup, Item 18 ("If I try hard enough, then I will understand the course materials") in the Control of Learning Beliefs subgroup, Item 20 ("I'm confident I can do an excellent job on the assignments and test in the this course"), and Item 21 ("I expect to do well in this class") of the Self-Efficacy Learning Performance subgroup. Each evaluated item was identified by the *Motivation and Strategies for Learning in a Fundamentals of Graphics Education Course* study as continuing motivational and learning factors. These items were analyzed with the NCLAGES categorical groups: Real World Relations, Personal Interest, Sense Making, Conceptual Associations, Applied Understanding, Problem Solving, Confidence in Problem Solving, Advanced Problem Solving, and General Attitudes.

Based on the correlation results, there is statistical support that the two studies (attitudes and opinions of fundamentals of graphic students and motivation and strategies for learning for fundamentals of graphics students) exhibit little or no correlation. This is evidenced by the strongest negative correlation (-0.11) on MSLQ Item 18 paired with the NCLAGES Personal Interest group and the strongest positive correlation (0.21) on MSLQ Item 21 in three of the NCLAGES groups: Real World Relations, Problem Solving, and General Attitudes.

Conclusions

No direct or strong correlations were found between the two areas of attitude from the NCLAGES instrument and motivation from the MSLQ instrument. Although weak, Item 21 of the MSLQ, "I expect to do well in this class," had the strongest positive correlation of the study but not deemed strong or moderate based on the correlation coefficient of 0.21. Although this MSLQ item is weak in correlation, it was the one item that the authors found to show any possible change of relationship from the two instruments looking at student attitude and their motivation in the classroom. A conclusion can be made based on this study that no direct relationship exists with this population that

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provides evidence that motivation to learn is related to student attitudes toward engineering and technical graphics and vice versa.

Recommendations include the use of the NCLAGES and MSLQ surveys from this study with secondary engineering and technical graphics students to establish the role of academic levels in determining student motivation to learn and their attitudes toward content and context. Instructor effectiveness as it pertains to student motivation and attitudes also needs careful study, especially in classroom settings where the courses are not required for students. More mixed methods analyses that span studies need to be conducted in our field of engineering and technical graphics. The researchers found little of this methodology used with the data collected in our field. It is requested that those professionals who teach research methods courses consider including this form of research and allow the field to mine its already existing data sources. Collaborations among researchers who employ these methods will contribute to a rich and integrated knowledge base for the field.

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About the Authors

Jeremy V. Ernst is an Assistant Professor in the Integrative STEM Education program of the Department of Teaching and Learning at Virginia Tech. He currently teaches graduate courses in STEM education foundations and contemporary issues in integrative STEM education. Ernst specializes in research focused on dynamic intervention means for STEM education students categorized as at-risk of dropping out of school. He also has curriculum research and development experiences in technology, engineering, and design education.
Email: jvernst@vt.edu

Aaron C. Clark is a professor of technology, design, and engineering education and Director of Graduate Programs and Associate Department Chair at North Carolina State University. Clark has worked in both industry and education, including college administration at various levels. His teaching specialties are in visual theory, 3-D modeling, technical animation, and STEM-based pedagogy. Research areas include graphics education, game art and design, and scientific/technical visualization.
Email: aaron_clark@ncsu.edu